SOLAR ENERGY OPTIONS FOR WESTERN WASHINGTON

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Is it really possible to use solar energy in Western Washington? After all, our climate is cloudy and rainy much of the year. Fortunately however, this lack of winter sun is offset by generally warm and sunny summers. In fact, on an annual average, Western Washington receives about 68% as much solar energy as Southern California. Thus, a solar energy collector in Washington with a 32% greater area than one in Southern California will produce about the same amount of energy. There are many options for using solar energy. This report includes only the most cost-effective solar approaches for Western Washington State. These include solar space heating, solar hot water, and solar electric energy. We do not discuss biomass energy, wind power, or other renewable energy sources, which are also possible.

In all uses of solar energy, it is important to have a location which is open to the sun on the south side without appreciable shading from about 9 in the morning until 3 in the afternoon. The effect of shading, for example from an evergreen tree, can be determined quickly using a Solar Pathfinder. This instrument is placed near the planned location of a solar collector. It provides a map of the sun's path each hour of the day and each month of the year, and can determine the percentage of the total available solar energy which will be blocked by the shading from a tree or a building.

I. SOLAR SPACE HEATING

Of the total energy used by an average residence, about 61% is for space heating. In Western Washington most of this can be supplied by solar energy. Solar space heating relies on the green house effect. Like a green house, a glass collecting surface transmits visible light to the interior (or collector) space. That energy is reflected at longer wave lengths of infrared energy to which glass is opaque; thus heat is trapped within the interior space.

Existing homes can sometimes be retrofited to utilize solar space heating (see active heating below). However, the best approach is to incorporate “passive” solar design into the original building plan. Passive solar heating involves no fans, pumps or active circulation. It is the most cost-effective approach and is ideally suited to our climate in Western Washington, where overall winter heating demand is relatively low, nights are overcast and not extremely cold, summers are mild, and air-conditioning is not required. Our experience indicates that with proper design, about 70% of residential heating requirements in Western Washington can be obtained from passive solar heating. Solar space heating strategies should: 1) maximize winter heat gain, 2) incorporate heat storage, 3) minimize heat loss, 4) minimize summer heat gain, and 5) utilize cost-effective approaches.

First, winter heat gain can be achieved using either passive or active heat collection. In passive solar heating, the building should be designed with a long east-west axis to maximize the south wall area. Relatively large areas of window glass are placed on the south wall of the house. At our latitude (49 degrees) south windows gain about 1232 Btu /square foot of glass /day on average in December.

Active solar space heating can also be used in Western Washington. This approach relies on air or liquid collectors that concentrate the solar heat gain. Heated water is then circulated through pipes using pumps, while heated air is circulated through ducts with fans. The heat is transferred directly to the interior space or to storage for later use. Differential thermostats are generally used to control the heat flow. For example, a recent 2800 square foot home designed by Western Solar incorporates a 4 foot wide sun space with glass covering the entire south wall of the home. Inside the sun space are 42 cylinders holding a total 1786 gallons of water for thermal mass heat storage. This home derives about 70% of its annual heating requirement from solar energy.

Active solar heating can also be accomplished by using hot air collectors combined with duct fans to the heated space or by using hydronic in-floor or radiant heat with roof-mounted hot water collectors. However, these two approaches are more effective in climates which have more winter sun days than Western Washington.

Second, the heat gained through south windows needs to be stored and available at night or during less sunny days. This can be accomplished in a cost-effective way by using insulated concrete slab floors, masonry interior walls or interior water storage tubes. Concrete slab floors (4 to 6 inches thick) need at least 3 inches of EPS foam insulation underneath to minimize heat loss. An interior wall of 8 inch thick concrete block (voids filled) can be covered with attractive textured plaster. Water storage tubes 12 to 18 inches in diameter and 8 to 10 feet high in the interior space are very effective and store 3 times more heat per volume than concrete.

Third, good solar space heating design requires minimization of heat loss through the use of good insulation, advanced framing, structurally insulated panels, insulated concrete forms, or insulated concrete block construction, high performance windows and doors and nighttime window coverings. For example, interior insulating blinds can be lowered to cover windows at night to minimize nighttime heating loss through glass windows.

Fourth, to minimize summer heat gain the building should be well insulated with R-50 in the ceiling and a minimum of R-23 in the walls. Solar powered attic fans can be used to minimize attic heat accumulation. Most important however is the use of well-designed shading on south facing windows. South roof soffits or eave overhangs should be designed to provide summer shade on south windows, but allow the lower winter sun to penetrate to the interior of the building.

Finally, building design and material choices need to be cost-effective. Spending $10,000 on a solar collector system to save $50 per year in heating costs may save greenhouse gas emissions, but makes little sense as an investment. Fortunately, with the right choices solar space heating can be accomplished for very little or no additional cost. A well-insulated passive solar building requires very little back-up heat. Instead of a large and expensive auxiliary heating system, heat can often be provided by a fireplace or a few radiant electric panels. South windows and good day lighting mean that electric light use is reduced.

A well designed passive solar heated building can more than pay for itself. Heating costs for a 2000 square foot home in Western Washington can be reduced from a typical $852.00 a year to about $150.00 per year. With this initial savings and with

natural gas costs increasing about 14% a year, a solar home will save more than $35,000.00 in heating costs over a 15 year period.

II. SOLAR WATER HEATING

About 30% of residential energy consumption is used for heating water. Thus, solar water heating provides probably the second most cost-effective use of solar energy. In the Pacific Northwest, a solar hot water system must be protected against winter freezing. The most cost-effective system uses a flat plate collector (usually roof-mounted) in which water containing nontoxic propylene glycol antifreeze circulates through copper tubing inside an insulated glass covered collector. The glycol solution coming into the collector is heated and returned to a solar storage tank containing a heat exchanger. The heat exchanger transfers the solar heated water to the hot water storage tank. From this hot water storage tank, water moves either to a second backup electric or gas heated tank or through an on-demand heater. Or in a single tank system, the solar hot water storage tank contains a backup electric heating element to maintain the desired temperature. In the summertime, solar energy provides about 100% of the water heating requirement. In the wintertime, when enough solar energy is not available, backup heat either electric or gas maintains the desired hot water temperature. A typical system with two hot water collectors can produce about 70% of the annual solar hot water requirement for a family or 2 or 3 in the Pacific Northwest.

III. SOLAR ELECTRIC

Solar electric panels convert sunlight to electricity. The most common type of solar panel is based on polycrystalline silicon, a semiconductor material that converts photons to electrons with an efficiency of about 15%. A number of small silicon cells are hooked together in series to make up a solar panel (also called a module). A collection of panels, often mounted on the roof or on a ground mount or pole mount system, is called an array. Direct current produced by the solar panels goes to an inverter and is converted to 120 volt alternating current for normal use. In a grid-tied system, anytime the solar panels are producing more than is being consumed in the building, electricity flows back to the utility grid, essentially running the electric meter backwards. Batteries are only required for off-grid systems or to maintain power from a grid-tied system during a power outage. In Washington State, as in most regions, net metering means that you are billed monthly only for the net amount, i.e. the amount you use minus what you feed back to the grid. So depending on its size, a solar electric system may reduce your monthly electric bill by 30%, 50%, or even 100%.

Solar electricity can be used to run electric furnaces or baseboard heaters for space heating or electric hot water heaters. However, heat produced by electrical resistance is not efficient and thus is not very cost-effective. The best use of electricity is for efficient light fixtures and appliances. Solar hot water is best produced with the solar hot water technology described above.

IV. SOLAR ECONOMICS

We are frequently asked if one should wait until the price of solar technology goes down. Actually, there is no better time to invest in a solar system than now. The price of solar systems is dictated, as with most items, by supply and demand. For example, the price per watt decreased about 30% from 1991 to 2003. Then between 2003 and 2004 world supply did not keep up with demand and price levels actually increased before again dropping back almost to 1991 levels. Advances in cell technology and efficiency are occurring but very slowly. So this is a great time to invest in solar energy.

Solar electric systems require little or no maintenance. There are no moving parts and the panels usually have a 25 year warranty. The inverters are warranted for at least 10 years and good quality solar batteries can last for 5 to 15 years.

There is a significant initial investment for a solar electric system. For example, a 3 kilowatt grid-tied system installed may run about $28,500. However, federal, state and utility incentives offset much of cost of solar electric systems. For example, in Washington State in addition to net metering, the state requires utilities to pay the producer of solar electricity 15 to 18 cents per kilowatt hour for all the solar electricity produced, regardless of whether it is used or not. Also, on September 23, 2008 the U.S. Congress passed the "Energy Improvement and Extension Act". This act provides, among other things, an Individual Income Tax Credit amounting to 30% of the total installed cost of solar electric systems installed from January 2009 through 2016. Also, under this act, businesses can claim the 30% Tax Credit as well as accelerated 5 year depreciation.

Investment in solar space heating, hot water or electric, will increase the value of a home. According to studies in Appraisal Journal, October 1998, the selling price of homes increases about $21.00 for every $1.00 decrease in annual fuel bills. Thus a solar home that may save $700.00 per year in heating costs would have an added value of $14,593.00 compared to a traditional home. This added property value along with savings on energy, and federal and state incentives add up to a 14% annual tax-free return on investment.

Of course, in addition to the financial benefits of utilizing solar energy there is the reduction in our dependence on oil imports and the reduction in green house gas emissions. For example, a 5 kilowatt solar electric system over a 25 year period will eliminate about 97 tons of carbon dioxide emissions normally produced by coal fired or oil fired power plants. This is equivalent to about 194,000 automobile miles.

Solar energy in Western Washington is cost-effective, good for the environment, and buildings can be designed to use zero net energy. A case in point is a solar home in Bellingham, Washington. There passive solar heating provides most of the space heating requirement of 8,856 kilowatt hours per year. Hot water is provided by a flat-plate closed-loop solar collector system, and a solar electric system once expanded will provide about 9.3 kilowatts. This home produces as much energy as it consumes.

In summary, solar energy in Western Washington can reduce your annual heating bills, increase the value of your home or business, and reduce fossil fuel greenhouse gas emissions.

MORE INFORMATION

Climate Change: Causes, Effects, and Solutions http://www.amazon.com/Climate-Change-Causes-Effects-Solutions/dp/0470850191/ref=ed_oe_p

Data Base for State Incentives for Renewables and Efficiency http://www.dsireusa.org/

Solar Washington www.solarwashington.org

U.S. EPA Clean Energy Program http://www.epa.gov/solar/

U.S. Department of Energy / Solar http://www.energy.gov/energysources/solar.htm

Washington State University http://www.energy.wsu.edu/projects/renewables/solar.cfm

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